

Physician Practice Variation in Electronic Health Record Use

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Project Period: 09/01/2015 - 08/31/2016

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Funding provided by the Agency for Healthcare Research and Quality

Grant No. R36 HS23719

Structured Abstract

**Purpose:** Examine the prevalence of variation in electronic health record (EHR) documentation in physician practice, its causes, effects, and strategies to mitigate its potential for harm.

**Scope:** Primary care practices in the U.S.

**Methods:** Mixed methods including multilevel modeling of national EHR vendor data and semi-structured qualitative interviews with primary care providers and practice staff.

**Results:** Among a national sample of primary care practices, comparison of the proportion of encounters in which providers completed documentation revealed substantial variation in documentation of patients' problems, providers' assessments and diagnoses, patients' social history, the review of system, and communication about lab and test results. Multilevel modeling of the most variable categories revealed that most of the observed variation could be explained by differences in documentation across providers in the same practice, suggesting providers make different decisions about documentation for comparable patients. Qualitatively, practice members perceived variation as a commonplace phenomenon, yet also attributed inefficiencies in care delivery and risks to safety and quality from missed or misinterpreted information to variation in documentation within their practices. Respondents identified additional training, ongoing meetings, and improvements in EHR design as potential strategies to prevent harm.

**Key Words:** primary care practices, electronic health records, mixed methods

### **Purpose**

The purpose of this study was to examine the prevalence of variation in electronic health record (EHR) documentation in physician practice, its causes, effects, and strategies to mitigate its potential for harm, focusing on the following three research questions:

- (1) For core categories of clinical documentation, are there any categories that reflect high variation across primary care physicians in the same practice?
- (2) What are the perceived causes of such variation in EHR documentation and how, if at all, do primary care providers and staff perceive that variation affects their ability to use their EHR to deliver high-quality care?
- (3) What strategies could be implemented in primary care practices to prevent or mitigate the negative consequences of variation in EHR documentation?

### **Scope**

Substantial public and private funding has been invested to increase physician adoption of EHRs, motivated by the expectation that EHR use would lead to higher-quality, lower-cost care. While there is a growing body of evidence supporting these benefits, there is also recognition of the unintended ways in which EHR use impedes delivery of higher-quality, lower-cost care (1, 2). One such domain is provider-to-provider variation in EHR documentation -- that is, differences in the content, structure, or location of the same patient information in the EHR that are not wholly due to differences in patients' clinical status. Such variation in how information is documented in the EHR will likely challenge users' abilities to find and act on relevant details of the patient's history. It is also likely to impede tools designed to automatically extract information from the patient chart, such as clinical decision support functionality that alerts users to best practice management of medical conditions as well as reports to manage patient populations.

### **Methods**

#### ***Summary***

We use a sequential, explanatory mixed-methods design. We first use data from a national EHR vendor to quantify the extent of physician-to-physician variation in 15 categories of clinical documentation for 809 primary care providers in 237 practices. Once we identified documentation categories with high variation, we use semi-structured interviews with physicians and staff in 10 primary care practices to explore the causes and consequences of such variation as well as to identify strategies to prevent or mitigate negative consequences. The study was approved by the Michigan Institutional Review Board (OHRP IRB Registration Number IRB00000246).

#### ***Quantitative Setting and Data***

We obtained de-identified EHR log data from a commercial, web-based EHR vendor. The vendor automatically captures and stores clickstream data when users are logged in to the EHR. We worked with the vendor to aggregate clickstream data to 15 mutually-exclusive clinical documentation categories, such that a given click would represent a documentation action in the given category (see Table 1).

**Table 1: Description of Clinical Documentation Categories**

<b>Clinical Documentation Category</b>	<b>Definition</b>
<b>Assessment &amp; Diagnosis</b>	Synthesis of the thought processes of the provider caring for the patient.
<b>Collect Clinical Encounter Reason</b>	The purpose of the patient's visit.
<b>Collect Vitals</b>	Measurement of the body functions, such as body temperature, blood pressure, pulse (heart rate), and breathing rate (respiratory rate); includes documentation of adding, removing, or reviewing information.
<b>Conduct Physical Exam</b>	The medical professional examines the body of a patient for signs of disease, pertinent normal findings, and relevant negative findings.
<b>Conduct Procedure</b>	A course of action intended to achieve a result in the care of persons with health problems (e.g., insertion of an intrauterine device or removal of a wart).
<b>Conduct Review of Systems</b>	The status of the patient's organ systems, with a focus upon the subjective symptoms perceived by the patient. This category is a survey of the patient to complement the specific findings from the History of Present Illness.
<b>Confidential Information</b>	Information which the patient has requested to keep private; includes documentation of adding, removing, or reviewing information.
<b>Creating/Sending Out Orders</b>	Instructions by the medical practitioner for the treatment of the patient.
<b>History of Present Illness</b>	The interview prompted by the chief complaint or presenting symptom (e.g., a cough); includes documentation of adding, removing, or reviewing information.
<b>Interpret Incoming Clinical Data</b>	Interpretation of the results of tests, other notes, etc.
<b>Medication List</b>	The prescription and non-prescription medications the patient is taking or has taken; includes documentation of adding, removing, or reviewing information.
<b>Problem List</b>	The list of diagnoses the patient has or has had; includes documentation of adding, removing, or reviewing information.
<b>Review/Discuss Documents</b>	Documentation of discussion of external documents with the patient.
<b>Sign-off/Close Encounter</b>	Documentation of closing the encounter.
<b>Social History</b>	The patient's lifestyle practices (e.g., diet, exercise) and habits (e.g., smoking, alcohol consumption); includes documentation of adding, removing, or reviewing information.

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Every documentation action is tied to a patient visit (“encounter”) ID as well as a user ID. Users include providers (MDs, DOs, NPs), clinical support staff (e.g., Mas and RNs), and administrative staff. User IDs serve to associate each documentation action to user’s role (e.g., provider, staff), specialty (for providers only), organizational affiliations such as the office the user practices in and the overarching Provider Organization that office belongs to, and geographic affiliations.

The dataset provided by the EHR vendor included all documentation actions in all 15 categories for each encounter that occurred in the month of June 2012 in all ambulatory primary care practices that were using the vendor’s system. The final analytic sample included 170,332 encounters led by 809 primary care providers nested in 237 practices spread across 27 states.

#### ***Measures***

##### ***Dependent Variables: Level of Documentation Actions per Provider***

For each provider, we created a measure of the proportion of their encounters with one or more documentation actions in each of the 15 documentation categories. For example, if a provider updated or reviewed a patient’s problem list in 5 out of 20 encounters in the month, his or her proportion would be 0.25 for that measure.

##### ***Identifying Variables: User Specialty and Levels in the Data***

We created a categorical variable for provider primary care specialty type. We also created a set of identifiers to capture the nesting of providers within practices, practices within provider organizations, and provider organizations within states.

#### ***Analytic Approach***

To determine which of the 15 documentation categories had high variation, we compared the median and interquartile range across the 809 providers for each category. For the high variation documentation categories, we measured the proportion of variation occurring across providers in the same practice by estimating a multilevel linear regression model in Stata [21] with provider documentation as the dependent variable, primary care specialty as an independent variable, and random effects variables to capture variation at the other levels of nesting. We calculated the ratio of explained variation for each of these levels to the total variation across levels and tested whether the ratio was statistically different from zero using bootstrapped standard errors. To counteract the problem of multiple comparisons, we applied the Bonferroni correction and set the threshold for statistical significance at 0.0125. We interpret a ratio statistically different from zero as a meaningful amount of explained variation.

#### ***Qualitative Setting and Data***

We used a list of practices maintained by Michigan’s Regional Extension Center to identify internal or family medicine practices using a commercial EHR in southern- and mid-Michigan. We restricted the sample to practices with at least two providers to ensure there was an opportunity for variation across providers within the same practice. We sent an invitation letter to the practice manager at the 51 practices that met these criteria, and 10 agreed to participate.

In each participating practice, we conducted face-to-face interviews with at least one provider and one other respondent who regularly used the EHR. Interviews lasted 30-90 minutes and were

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a mix of one-on-one and group interviews, based on respondents' preferences. All interviews were transcribed. Each respondent received a \$75 gift card. Data collection occurred between February and May 2015.

We developed a semi-structured interview guide that asked respondents about perceived variation in EHR documentation, factors that caused variation, the effects of such variation on the delivery of high-quality care, and strategies to manage variation either by preventing its occurrence or mitigating its negative effects on delivering care (available upon request). The protocol was structured around the documentation categories identified as most variable in the quantitative component of the study, and also asked respondents to identify other categories of high variation documentation. The interview protocol was piloted in a convenience sample of two primary care providers and refined based on their feedback before being used.

***Analytic Approach***

We developed an a priori code list (3-5) based on our research questions. One member of the research team applied these codes to three transcripts, chosen to represent different types of potential respondents. Next, two other members of the research team independently reviewed the final code list and the three coded transcripts to ensure comprehensiveness and consistency. The original member of the research team applied the final code list to the remaining 37 interviews. We uploaded all coded interviews to Atlas.ti (6) and used the query function to group the different sections of the interviews by code. We synthesized this information in analytic matrices (7) to identify issues that emerged in interviews across multiple practices, including the number of practices with variable documentation for each high variation documentation category and recurring challenges as a result of variation in documentation.

**Limitations**

This study uses novel datasets to quantify and explain variation in EHR documentation in primary care practices across the country. While the findings provide an important window into variation in documentation beyond single institution studies, there are several limitations that must be taken into account. First, the de-identified EHR data lack patient characteristics and conditions, and it is possible that the observed variation is the result of differences in care delivery. However, the presence of these patterns in qualitative interviews confirms the likelihood of the phenomenon. Second, qualitative data collection relied on respondents' perceptions, which were not compared to data from their EHR data to more conclusively determine the prevalence of certain forms of variation. Although multiple perspectives were triangulated within and across practices to gain a more comprehensive account, the small number of respondents at three practices introduced additional limitations to this process (8). Finally, the practices included in both arms of this study were primarily small primary care practices. The prevalence of certain forms of variation, the impacts they have on care delivery, and the utility of different strategies may be different in larger practices or specialty practices, and should be explored in future research.

**Inclusion of AHRQ Priority Populations**

To ensure inclusion of AHRQ priority populations, qualitative respondents were asked about the relationship between variation and documentation of healthcare for women; children; racial and ethnic minorities; populations with special healthcare needs (chronic illness, disabilities, and end

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of life care needs); elderly patients; low-income patients; inner-city patients; or rural patients. Furthermore, 7 of 10 practices participating in the qualitative component of the study were federally qualified health centers (FQHCs), and particularly likely to treat priority populations.

**Results*****Quantitative and Qualitative Samples***

The average practice in the quantitative sample had 12.6 providers and 13.9 additional users, including administrative and clinical support staff. Practices had been using the EHR for 51.4 months (4.3 years) on average. Providers in the sample were 46 years old on average and had 16.7 encounters per day on average. The most common specialty was family medicine (69.1%), followed by internal medicine (18.1%) (see Table 1).

**Table 1: Descriptive Characteristics of the Quantitative Sample**

<b>Practice-Level Variables</b>	<b>Mean</b>	<b>Std.</b>	<b>Min</b>	<b>Max</b>
<b>Number of Providers per Practice</b>	12.6	15.9	2	65
<b>Number of Other Users per Practice</b>	13.9	10.1	0	45
<b>Number of Total Users per Practice</b>	26.3	22.7	2	89
<b>Months on the EHR</b>	51.4	44.4	6	213
<b>Provider-Level Variables</b>	<b>Mean</b>	<b>Std.</b>	<b>Min</b>	<b>Max</b>
<b>Provider Age (years)</b>	46.3	11.5	25	81
<b>Provider Daily Encounter Volume</b>	16.7	8.4	5	41
<b>Number of Users Per Encounter*</b>	2.2	0.5	1	4
<b>Provider Specialty</b>	<b>Freq.</b>	<b>Percent</b>	<b>Cum.</b>	
<b>Family Medicine</b>	559	69.1	69.1	
<b>Internal Medicine</b>	146	18.05	87.14	
<b>OB/GYN</b>	50	6.18	93.33	
<b>Pediatric Medicine</b>	54	6.67	100	

\* Number of users completing any documentation during each encounter, including the provider

The qualitative sample included five independent practices and five practices that were part of a larger health system. Five different commercial vendors were represented in the sample. We interviewed a total of 40 individuals in varying roles across the 10 practices. We interviewed four individuals per practice, on average, ranging from two to six (Table 2).

Table 2: Practice Characteristics in the Qualitative Sample

Org.	Practice	Size	FQHC	EHR Vendor	Year EHR Adopted	Providers	Clinical Staff	Other Staff	Total
<b>A</b>	1	L (10+)	Yes	NextGen	2008	2	1	1	4
<b>B</b>	2	M (5-9)	Yes	Athenahealth	2012	2	4		6
<b>C</b>	3	M (5-9)	Yes	Epic	2012	1	2	1	4
	4	S (2-4)	Yes	Epic	2006	1	1		2
	5	M (5-9)	Yes	Epic	Unknown	4	1	1	6
<b>D</b>	6	S (2-4)	No	eClinical-Works	2015	1	1	3	5
<b>E</b>	7	M (5-9)	No	eClinical-Works	2013	2	1	2	5
<b>F</b>	8	M (5-9)	Yes	Athenahealth	2014	1		1	2
	9	S (2-4)	Yes	Athenahealth	2014	1	1		2
<b>G</b>	10	L (10+)	No	Cerner	2013	1	1	2	4
<b>Total</b>	NA	NA	NA	NA	NA	16	13	11	40

\*Providers includes physicians as well as nurse practitioners; Clinical Staff includes medical assistants and nurses; Other Staff includes medical directors, quality managers, and front office and other administrative staff

### ***High Variation Categories of Documentation***

We found that ten documentation categories had IQRs below 20%, but that five documentation categories had IQRs above 50%. We thus classify the following categories as high variation: (1) Updating the Patient's Problem List (IQR 73.1%, median 33.7%); (2) Conducting a Review of Systems (IQR 62.3%, median 73.5%); (3) Assessing and Diagnosing the Patient (IQR 60.4%, median 13.4%) (4) Updating the Patient's Social History (IQR 53.3%, median 76.1%); and (5) Reviewing and Discussing Documents (IQR 50.8%, median 18.7%) see Table 3).

Our multilevel models revealed that the majority of variation in these categories existed across providers within practices. Discussing Documents during the patient's visit had the most variation at this level (78.1%,  $p < .001$ ) and Documentation of Social History had the least variation at this level (62.2%,  $p < .001$ ) (see Table 3).



**Table 3: Characteristics of High Variation Documentation Categories**

Documentation Category	Completion (Median Across Providers)	Interquartile Range (25%’ile-75%’ile)	Percent of Explained Variation at Each Level			
			State	Provider Organization	Practice	Provider
Review/Discuss Documents	18.7%	50.8%	7.1%	5%	9.9%	78.1%**
		(10.3%-61.2%)	[0.03]	[0.04]	[0.06]	[0.04]
Assessment & Diagnosis	13.4%	60.4%	0%	8.3%	15.8%*	76%**
		(2.6%-62.9%)	[0.01]	[0.04]	[0.06]	[0.05]
Problem List	33.7%	73.1%	1.3%	9.7%	19%*	70.1%**
		(3.5%-76.6%)	[0.01]	[0.04]	[0.06]	[0.04]
Conduct Review of Systems	73.5%	62.3%	3.2%	15.6%*	13.5%*	67.7%**
		(32.9%-95.2%)	[0.03]	[0.05]	[0.05]	[0.04]
Social History	76.1%	53.3%	4%	17.8%**	16%*	62.2%**
		(39.5%-92.8%)	[0.02]	[0.04]	[0.05]	[0.03]

\*Bootstrapped standard errors appear in brackets. \*p<.0125 \*\*p<.001

### ***Perceived Drivers of Variation in Documentation***

All practices in the qualitative sample reported that there was variation in documentation across providers. Most respondents attributed variation to user preference, which was facilitated by the multiple options available to document each category of information. Further, each option reportedly placed different constraints on documentation, and users decided which set of constraints was most tolerable to them. One of the more common explanations for this variation related to providers’ preferences for structured or unstructured documentation.

Variation in documentation also stemmed from implementation procedures; many respondents pointed to the lack of training when they first acquired the EHR. One provider suggested that “*a lot of the variation*” in their practice was a result of training existing entirely on video instead of in-person, explaining that the format lead to people developing different documentation behaviors. In contrast, respondents from a practice that perceived very little variation in EHR documentation attributed their consistency to clearly articulated documentation procedures learned during implementation.

### ***Perceived Effects of Variation***

Many respondents perceived variation as having minor negative effects on the delivery of care, including extra time and effort to search for information. The subset of respondents concerned that variation in documentation interfered with quality of care reported that issues typically arose due to variation in documentation of patient problems because of its centrality in understanding a patients’ needs.

### ***Strategies to Manage Variation***

Frequent opportunities to discuss EHR documentation was the most commonly identified strategy to prevent variation in documentation, particularly if reinforced by follow up communications like e-mail. The second most commonly identified strategy to prevent variation

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was thorough training at the outset of implementation. Respondents believed that a clearer articulation of EHR functionalities and the dependencies of different documentation decisions could help achieve consensus regarding preferred practices. Other strategies identified by a smaller number of respondents included the use of scribes to complete documentation in a standardized way, increased automation of documentation to ensure information can be found in multiple places, financial incentives to motivate providers to adhere to a standard approach to documentation, and the development of standard workflows before transitioning to an EHR.

**List of Publications and Products**

Cohen, Genna R., Charles P. Freidman, Andrew Ryan, and Julia Adler-Milstein. “Physician Practice Variation in Electronic Health Record Documentation.” Podium presentation at the American Medical Informatics Association 2016 Annual Symposium, Chicago, IL 2016.

Cohen, Genna R., Charles P. Freidman, Andrew Ryan, and Julia Adler-Milstein. “Physician Practice Variation in Electronic Health Record Documentation.” Poster presentation at the AcademyHealth Annual Research Meeting, Boston, MA 2016.

**Conclusion**

Practices’ abilities to leverage EHRs for healthcare delivery improvements depend on how the EHRs are used to document care. This study is the first to measure how providers choose to complete clinical documentation across their encounters at a national scale, and it is also the first to explore EHR users’ perceptions of the causes and effects of variation. We find substantial variation in completion of documentation for a set of important clinical documentation domains that has the potential to undermine gains from EHR adoption, highlighting the necessity of targeted user-training during implementation and regular practice meetings focused on documentation.

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